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(54) **NETWORK PRINTING**

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H04L 29/08 (2006.01)

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See application file for complete search history.

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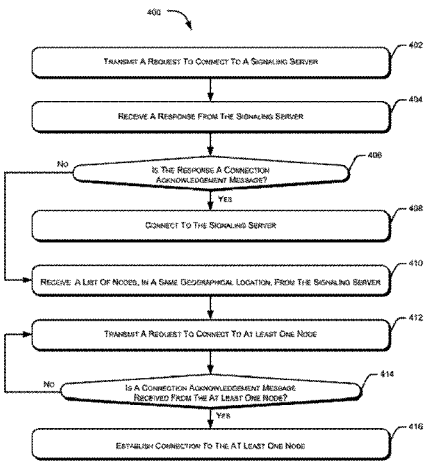
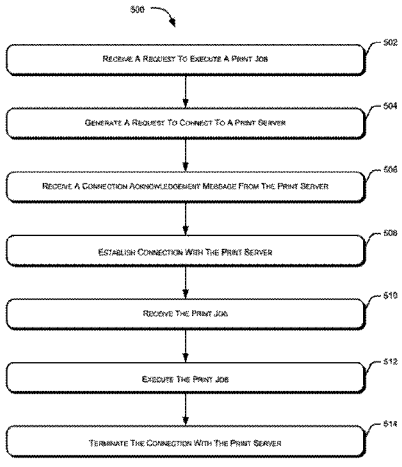
(57) **ABSTRACT**

Systems and methods for printing a document over a network are described herein. In one implementation, a method for network printing comprises receiving a request from a node to connect to a parent node and determining whether a number of child nodes of the parent node has reached a predefined threshold number. The method further comprises transmitting a connection acknowledgement message to the node on determining the number of child nodes not to have reached the predefined threshold number.

9 Claims, 8 Drawing Sheets





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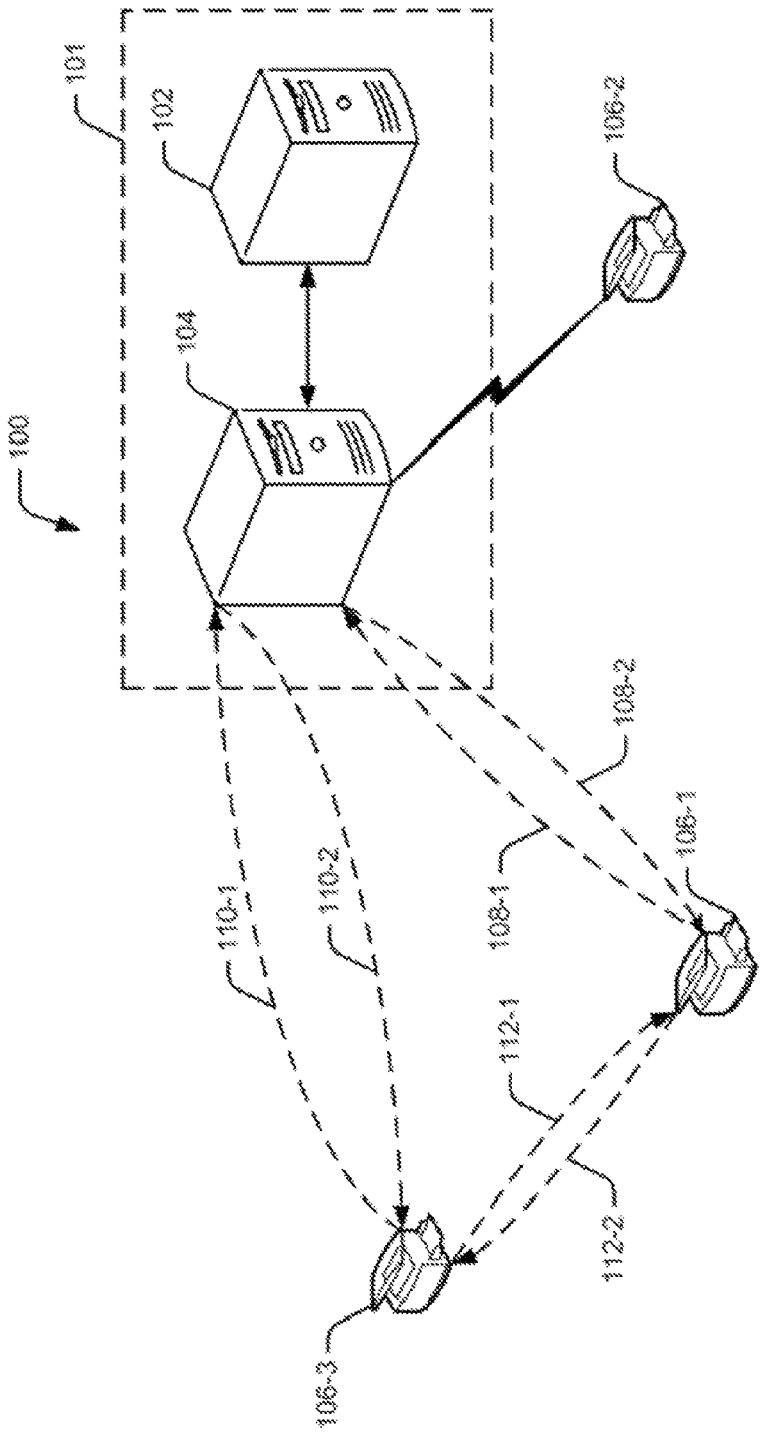

Figure 1a

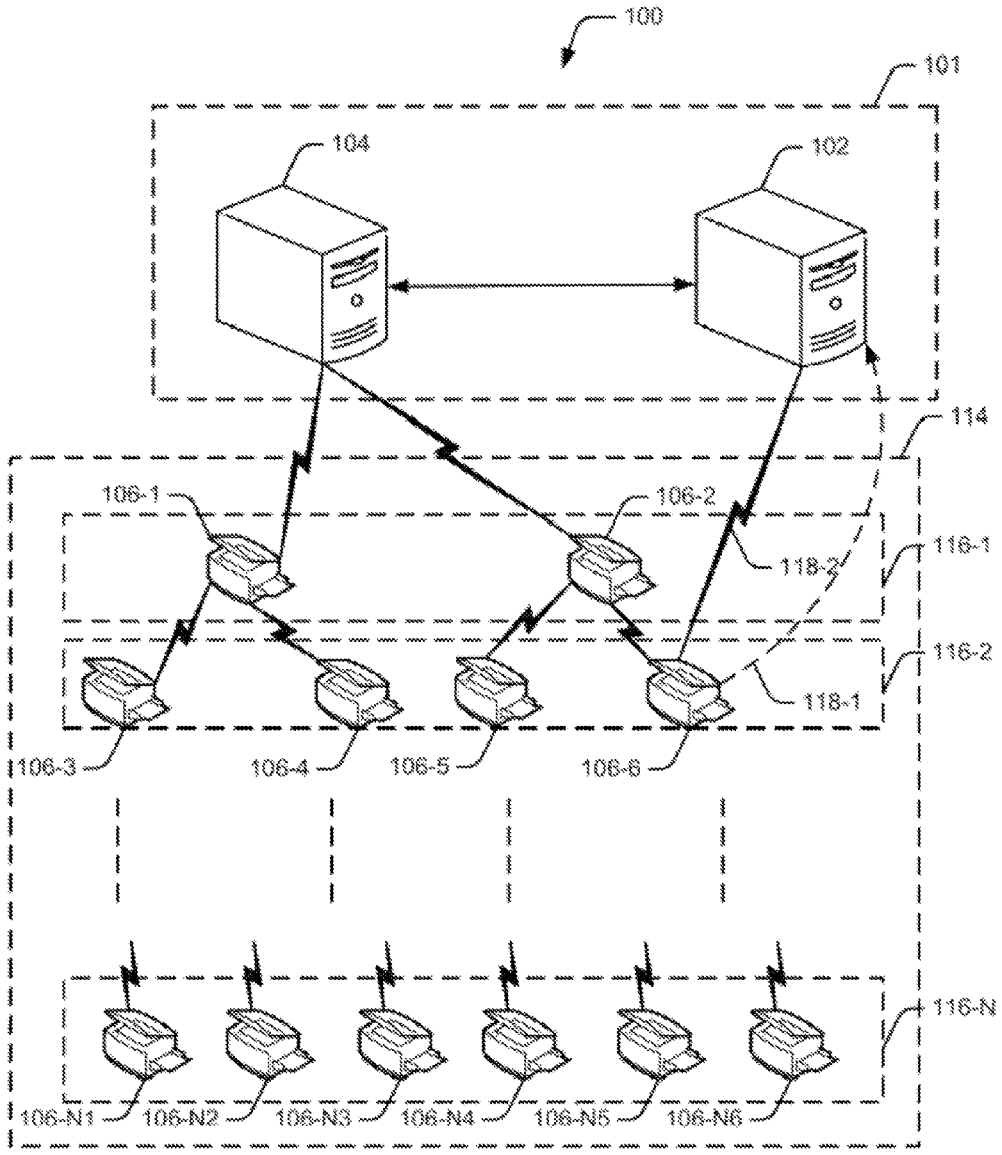
100
101
104
102
114
106-1
106-2
118-2
116-1
116-2
118-1
106-3
106-4
106-5
106-6
116-N
106-N1
106-N2
106-N3
106-N4
106-N5
106-N6

Figure 1b

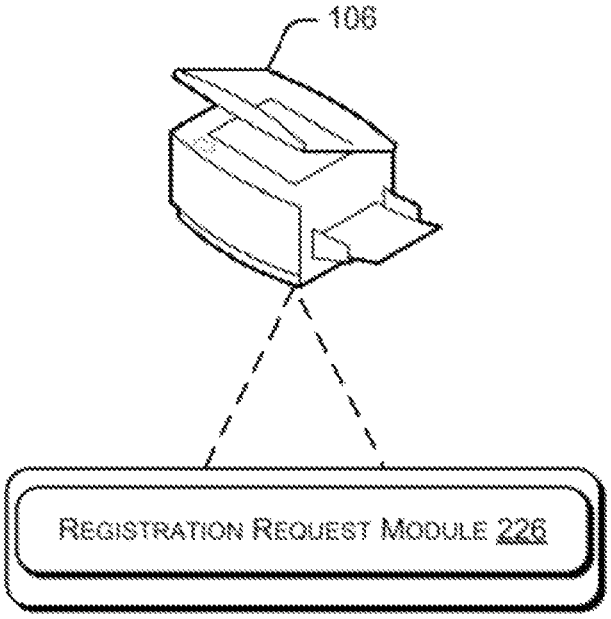

Figure 2a

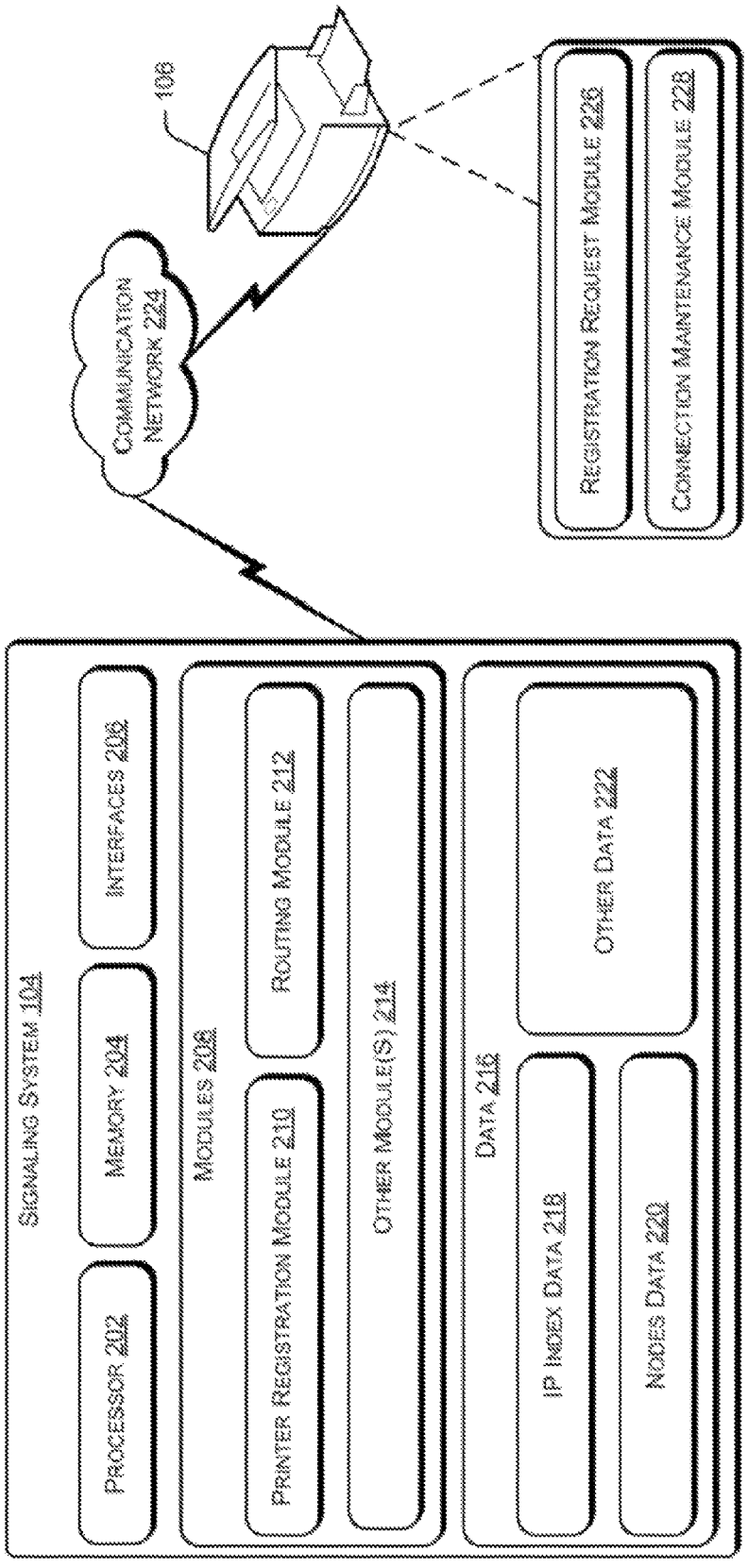
SIGNALING SYSTEM 104
PROCESSOR 202
MEMORY 204
INTERFACES 206
MODULES 208
PRINTER REGISTRATION MODULE 210
ROUTING MODULE 212
OTHER MODULE(S) 214
DATA 216
IP INDEX DATA 218
NODES DATA 220
OTHER DATA 222
COMMUNICATION NETWORK 224
106
REGISTRATION REQUEST MODULE 226
CONNECTION MAINTENANCE MODULE 228

Figure 2b

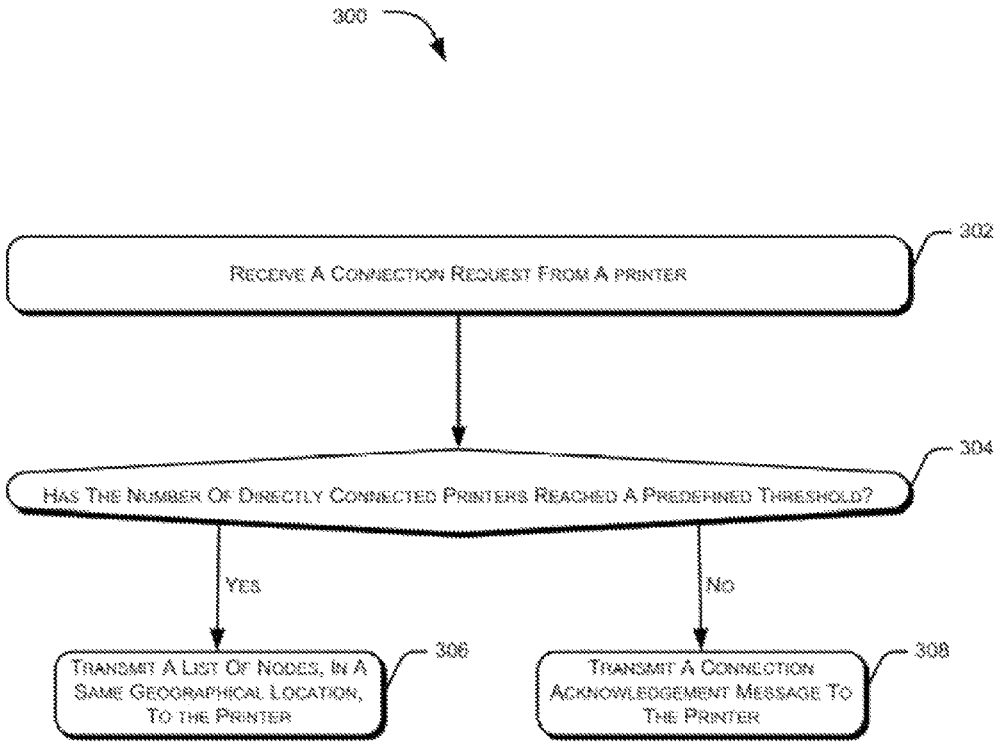
300
Receive A Connection Request From A printer
302
Has The Number Of Directly Connected Printers Reached A Predefined Threshold?
304
Yes
No
Transmit A List Of Nodes, In A Same Geographical Location, To the Printer
306
Transmit A Connection Acknowledgement Message To The Printer
308

Figure 3

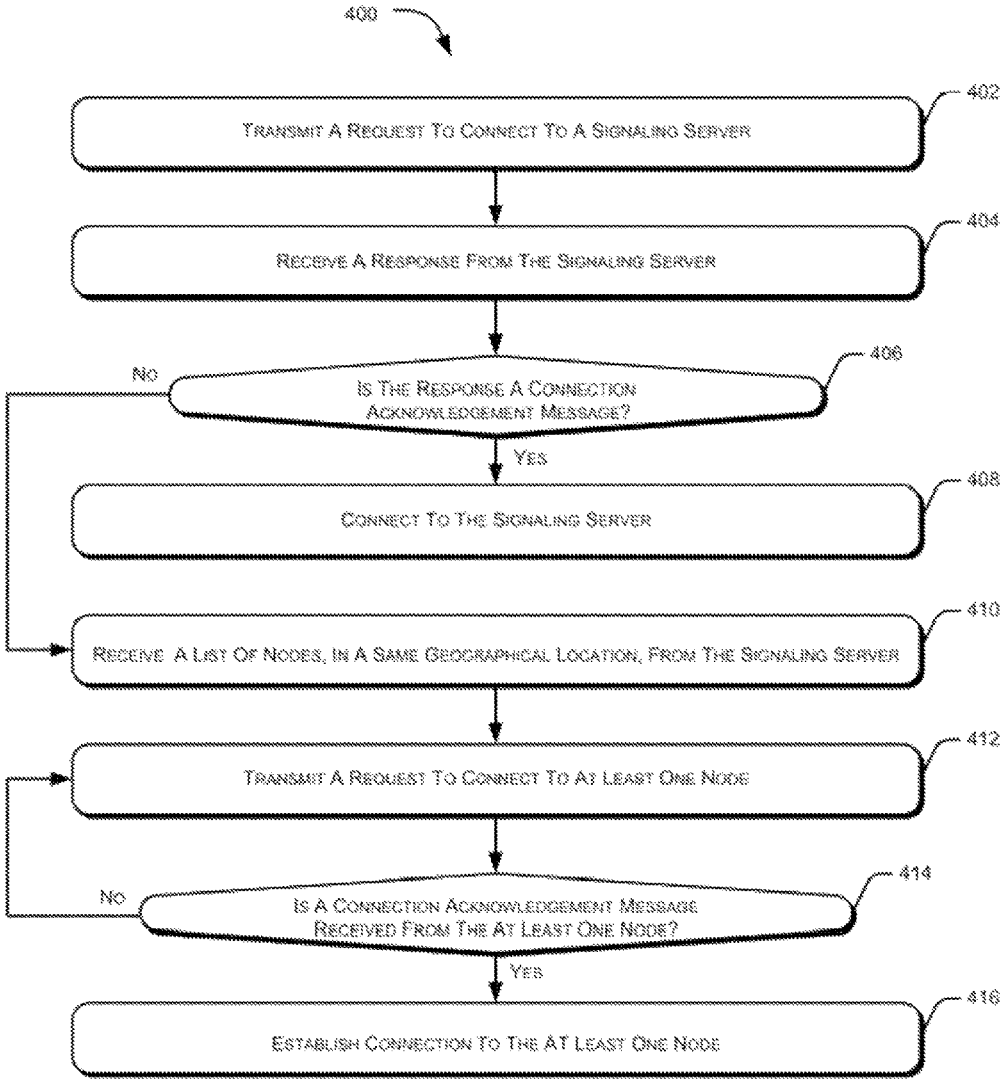
400
402
Transmit A Request To Connect To A Signaling Server
404
Receive A Response From The Signaling Server
406
Is The Response A Connection Acknowledgement Message?
No
Yes
408
Connect To The Signaling Server
410
Receive A List Of Nodes, In A Same Geographical Location, From The Signaling Server
412
Transmit A Request To Connect To At Least One Node
414
Is A Connection Acknowledgement Message Received From The At Least One Node?
No
Yes
416
Establish Connection To The At Least One Node

Figure 4

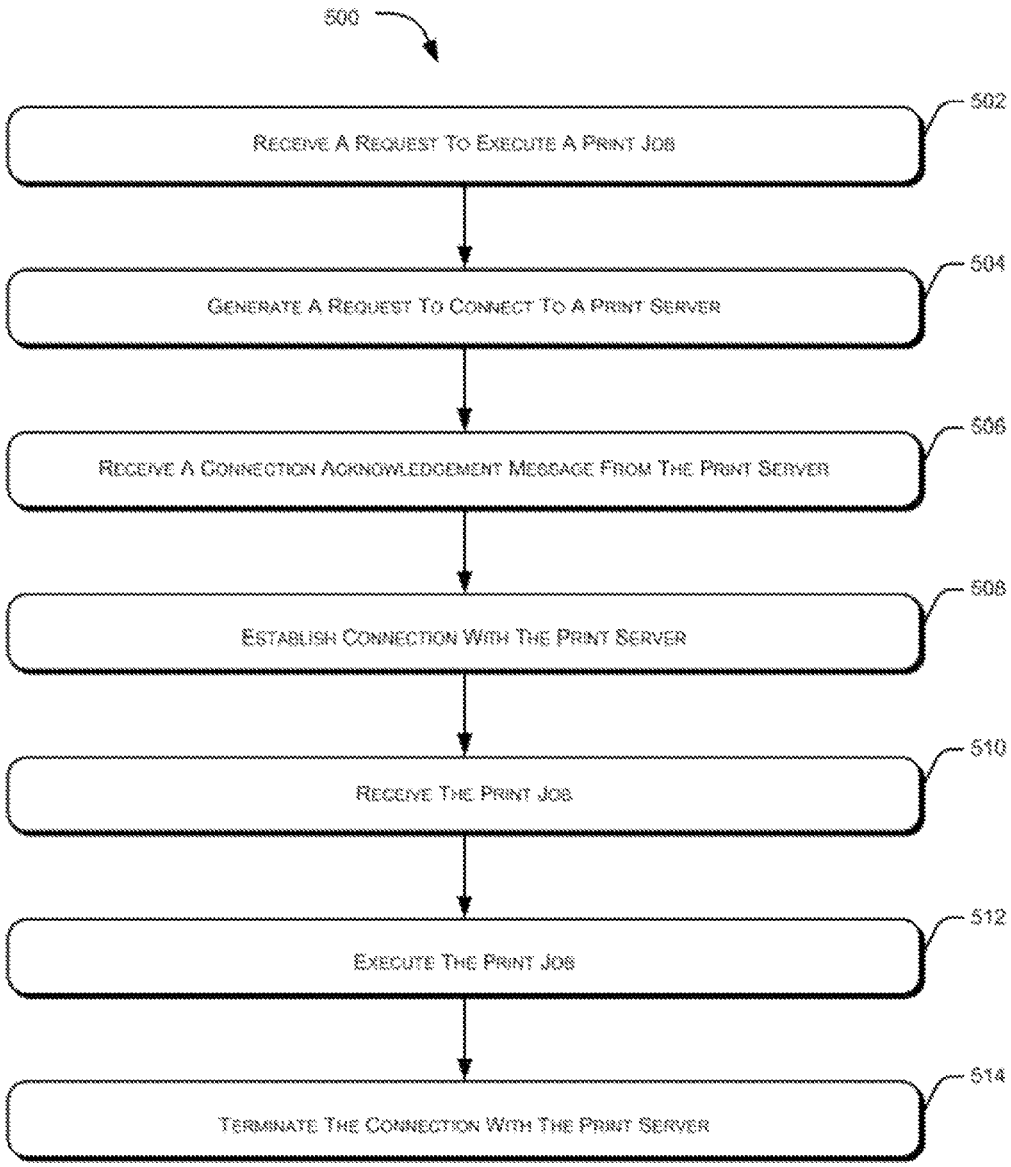
500
Receive A Request To Execute A Print Job
502
Generate A Request To Connect To A Print Server
504
Receive A Connection Acknowledgement Message From The Print Server
506
Establish Connection With The Print Server
508
Receive The Print Job
510
Execute The Print Job
512
Terminate The Connection With The Print Server
514

Figure 5

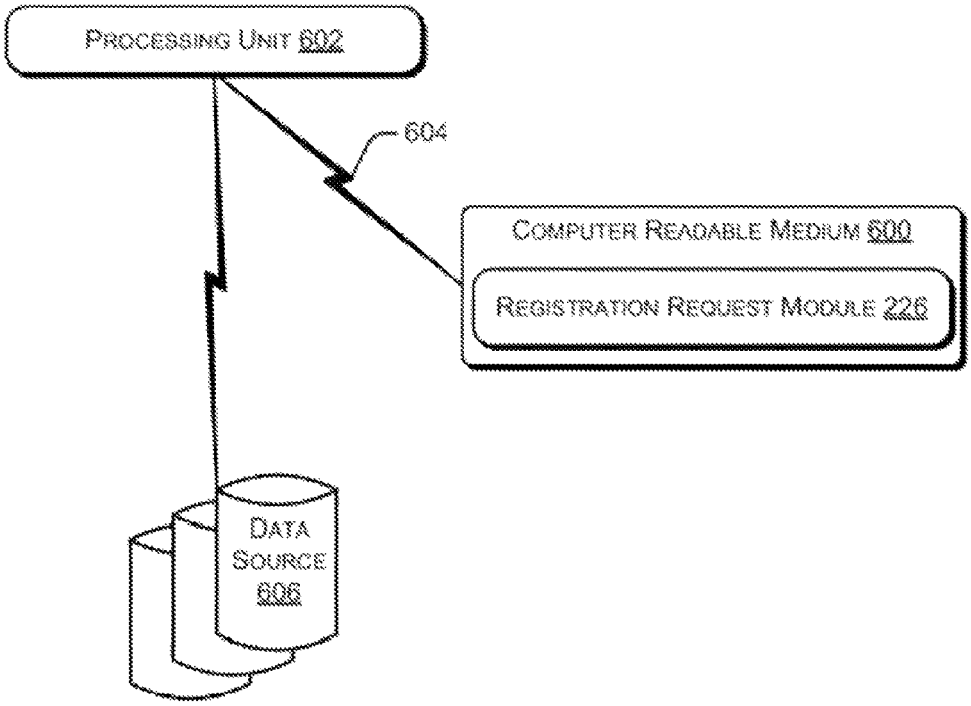
PROCESSING UNIT 602
604
COMPUTER READABLE MEDIUM 600
REGISTRATION REQUEST MODULE 226
DATA SOURCE 606

Figure 6

NETWORK PRINTING

BACKGROUND

The advent of communication networks has greatly enhanced the availability of shared resources to the users. One category of shared resources, used extensively over communication networks is that of network printers. The network printers facilitate multiple users to print documents, over the communication network, without having to install a printer driver on their computing systems.

Recently developed technologies facilitate printing using an electronic mail (e-mail) system instead a computing system. In such cases, each printer is identified using a unique e-mail address. The printers are usually connected to a print server over the communication network. In operation, the users send a print job by sending an e-mail to the print server. The print server scans the e-mail for detecting the presence of viruses and spam. The scanned e-mail, along with its attachments is then forwarded to the printer, which is identified based on the e-mail address for printing. The printers can also connect to the user's computing systems to send data, such as to send a scanned copy of a document.

BRIEF DESCRIPTION OF DRAWINGS

The detailed description is described with reference to the accompanying figures. In the figures, the left-most digit(s) of a reference number identifies the figure in which the reference number first appears. The same numbers are used throughout the figures to reference like features and components:

FIG. **1***a* schematically illustrates a network environment including a network printing system, according to an example of the present subject matter.

FIG. **1***b* schematically illustrates the network environment including the network printing system, according to another example of the present subject matter.

FIG. **2***a* schematically illustrates the components of a printer **106**, according to an example of the present subject matter.

FIG. **2***b* schematically illustrates the components of a signaling server and a printer, according to another example of the present subject matter.

FIG. **3** illustrates a method for network printing, according to an example of the present subject matter.

FIG. **4** illustrates a method for network printing, according to another example of the present subject matter.

FIG. **5** illustrates a method for network printing, according to another example of the present subject matter.

FIG. **6** illustrates a computer readable medium storing instructions for network printing, according to an example of the present subject matter.

DETAILED DESCRIPTION

The present subject matter relates to systems and methods for network printing. The methods and systems as described herein may be implemented using various commercially available computing systems and printers.

Generally, the printers implementing network printing techniques, such as ePrint and AirPrint, remain online and connected to a print server. However, for a major portion of time, most of the printers are idle or in an inactive state and only a small portion of the connected printers are active, i.e., only a small portion of the connected printers execute a print job. The inactive printers, which remain connected, increase

the number of Extensible Messaging and Presence Protocol (XMPP) connections that have to be maintained by the print server, and thereby increase the load on the print server.

In case of a glitch in the print server, all the printers connected to that print server attempt to reconnect with the print server or connect to a different print server which functions as an alias. This creates a connection wave which significantly increases the load on the print server and enhances the probability of failures in the operation of the print server.

Further, most of the service providers of network printing techniques have their print servers in data centers located at particular geographical areas where there is availability of communication bandwidth and power at low costs. Thus, printers located in far off geographical areas have to cross multiple network hops to connect with the print sewer. This increases the load on the communication network.

Commercially available techniques for improving the efficiency of systems implementing network printing techniques involve increasing the number of print servers so as to provide an optimal 'number of printers per print server'. However, increasing the number of print servers increases the expenditure for the service provider which in turn is recovered from the sale of the printer. Thus, the cost of printers implementing these network printer techniques increases which reduces the popularity of the printers amongst users.

The systems and methods, described herein, implement techniques of network printing. In one example, the method of network printing is implemented using a print server and a signaling server. The print server and the signaling server may be implemented as any computing device, such at personal computers, workstations, network servers and servers. In one implementation, the signaling server and the print server are communicatively coupled to each other.

In one example, a tree structure is formed using the interact protocol (IP) address of the signaling server and the printers as nodes. In said example, the signaling server acts as the root node. Some printers are then directly connected to the signaling server and are referred to as the child nodes of the signaling server. Further, certain printers can then connect to the directly connected printers. The directly connected printers can then act as patent nodes for the certain printers.

In operation, whenever a printer sends a connection request to the signaling server. The signaling server verities whether the number of printers directly connected to it has reached a pre-defined threshold number. In case, the predefined threshold number has not been reached, tide signaling server transmits a connection acknowledgement message to the printer and establishes a connection with the first printer. The connection acknowledgement message may be a response sent by the signaling server indicating that the signaling server is ready to establish a communication channel with the printer. The connection acknowledgement message may also indicate the port of the signaling server to which the printer should connect. For explanation, it is assumed that the signaling server supports a maximum of four printers directly connected to it. On receiving a connection request from a fifth printer, the signaling server transmits a list of printers directly connected to it, i.e., a list of the signaling server's child nodes. In one example, the signaling server maintains a list of internet protocol (IP) addresses of its child nodes and transmits the list to the fifth printer. The list may also indicate the geographical location of the child nodes.

The fifth printer then attempts to establish a connection with any of the child nodes of the signaling server, such as the first printer. In one example, the fifth printer may attempt to establish a connection with the child nodes of the signaling server in an ascending order of the geographical distance of the child node from the fifth printer. For explanation, it is assumed that the fifth printer attempts to connect with the first printer.

On receiving the connection request, the first printer verifies whether the number of printers directly connected to it has reached a pre-defined threshold number. In case, the pre-defined threshold number has not been reached, the first printer transmits a connection acknowledgement message to the fifth printer and establishes a connection with the fifth printer. The first printer also transmits a list of its peer nodes, i.e., a list of printers directly connected with the signaling server, to the fifth printer. The list of peer nodes may also indicate the geographical location of the peer nodes. This facilitates the fifth printer to establish a connection with the nearest peer node of the first printer in case of a break in connection with the first printer.

Once the first printer is directly connected with the pre-defined threshold number of other child nodes, i.e., printers, the first printer, on receiving a request from a new printer, transmits a list of its child nodes to the new printer. On establishing a connection with one of the child nodes of the first printer, the new printer transmits the address of the printer, to which the new printer is connected, to the signaling server. In one example, the signaling server maintains an IP index of IP addresses of the printers connected directly or indirectly to the signaling server. The IP index facilitates the signaling server to perform route data to a particular printer.

On the print server receiving a print job to be executed by a particular printer, the print server transmits a request to the signaling server for establishing a connection with the particular printer. The signaling server routes the request to the particular printer based on the IP index. The particular printer then sends a connection request to the print server for direct connection. On the direct connection being established, the print server transmits the print job to the particular printer for execution. On completion of the print job, the print server terminates the direct connection.

Thus, the systems and methods described herein, facilitate network printing using a reduced number of print servers as only the printers which have to execute a print job shall be connected to the print server. Further, in case of a glitch on one of the nodes, only the child nodes of the affected node, shall attempt to reconnect with the affected node or with the peer nodes of the affected node. This significantly reduces the number of reconnection requests. Further, since most of the nodes will be connected to a parent node and child nodes of nearby geographical region, the number of hops wilt be reduced, thereby reducing the load on the communication network.

The above systems and methods are further described in conjunction with the following figures. It should be noted that the description and figures merely illustrate the principles of the present subject matter. Further, various arrangements may be devised that, although not explicitly described or shown herein, embody the principles of the present subject matter and are included within its spirit and scope.

The manner in which the systems and methods for network printing are implemented shall be explained in details with respect to FIGS. **1** to **5**. While aspects of described systems and methods for network printing can be implemented in any number of different computing systems, environments and/or configurations, the examples and implementations are described in the context of the following system(s).

FIG. **1***a* schematically illustrates a network environment **100** including a network printing system **101**, according to an example of the present subject matter. In one example, the network printing system **101** further includes a print server **102** and a signaling server **104**. The print server **102** and the signaling server **104** may be implemented in various commercially available computing systems, such as servers, network servers, workstations and personal computers. The signaling server **104** is communicatively coupled with the print server **102**.

The network environment **100** further includes a plurality of printers, such as the printer **106-1**, the printer **106-2** and the printer **106-3**. The printers **106-1**, **106-2** and **106-3** are collectively referred to as the printers **106** and singularly as the printer **106**. The printer **106** may be implemented as a variety of printers, such as a office printer, a large format printer, an inkjet printer, a laser printer and a multi function printer. The printer **106** is usually associated with an e-mail address and includes interfaces which facilitate the printer **106** to connect with other computing systems and computer peripherals either directly or over a communication network. In one example, the printers **106** may implement various techniques of network printing, such as ePrint and AirPrint.

In one implementation, a printer **106-1** may send a connection request, indicated by arrow **108-1**, to the signaling sever **104**. On receiving the connection request, the signaling server **104** verifies whether the number of printers **106** directly connected to it has reached a pre-defined threshold number. In one example, the pre-defined threshold number may be defined by an administrator of the signaling server **104** based on the technical specification of the signaling server **104**.

In case, the pre-defined threshold number has not been reached, the signaling server **104** transmits a connection acknowledgement message, indicated by arrow **108-2** to the printer **106-1** and establishes a connection with the printer **106-1**. In one implementation, the connection between the printer **106-1** and the signaling server **104** may be in accordance with TCP/IP protocol. For explanation, it is assumed that the signaling server **104** supports a maximum of two printers directly connected to it. Thus, the connection request from the printer **106-2** shall also be accepted by the signaling server **104** in a similar manner as described above.

When the printer **106-3** sends a connection request, indicated by arrow **110-1**, the signaling server **104** determines that the number of printers **106**, directly connected to it, has reached the pre-defined threshold number. The signaling server **104** then transmits, as indicated by arrow **110-2**, a list of child nodes, i.e., the printers **106-1** and **106-2**, directly connected with the signaling server **104**. The list of child nodes may include the IP addresses of the printers **106-** and **106-2**, and the geographical location of each of the child nodes. In one example, the printer **106-3** may attempt to connect with any of the child nodes of the signaling server **104** in a random order. In another example, the printer **106-3** may attempt to establish a connection with the child nodes of the signaling server in an ascending order of the geographical distance of the child node from the printer **106-3**. For explanation, it is assumed that the printer **106-1** is geographically closer to the printer **106-3**.

On receiving the connection request, indicated by arrow **112-1**, from the printer **106-3**, the printer **106-1** verities whether the number of printers **106**, directly connected to it, i.e., the number of child nodes of the printer **106-1**, has

reached a pre-defined threshold number. In case, the pre-defined threshold number has not been reached, the printer **106-1** transmits a connection acknowledgement message, indicated by arrow **112-2**, to the printer **106-3** and establishes a connection with the printer **106-3**. In one implementation, the connection amongst the printers **106** may be based on peer to peer (P2P) protocol. The printer **106-1** also transmits a list of its per nodes, i.e., a list of printers **106**, directly connected with the signaling server **104**, to the printer **106-3**. The list of peer nodes may also indicate the geographical location of the peer nodes.

Once any of the printers **106** is directly connected with the pre-defined threshold number of child nodes, the printer **106** on receiving a request from a new printer **106**, transmits a list of its child nodes to the new printer **106**. On establishing a connection with one of the child nodes of the first printer **106**, the new printer **106** transmits the address of its parent node to the signaling server **104**.

In one example, the signaling server **104** may maintain an IP index of IP addresses of the printers **106** connected directly or indirectly to the signaling server **104**. The IP index facilitates the signaling server **104** to perform route data to a particular printer **106**.

Thus, the signaling system **104** facilitates generating and internet protocol (IP) tree of printers **106** connected directly or indirectly with the signaling server. The IP tree may be implemented as a data structure that simulates a hierarchical tree structure with a set of linked nodes. In one example, the signaling server **104**, represented by its IP address, may be the root node. The root node may be connected to one or more printers **106**, represented by their IP addresses. The IP tree is explained in greeter detail in conjunction with FIG. **1***b*.

FIG. **1***b* schematically illustrates the network environment **100** including the network printing system **101**, according to another example of the present subject matter. As mentioned earlier, the signaling server **104** generates an IP tree **114**. The IP tree **114** includes the printers **106** which are connected at different levels. For example, the printers **106-1** and **106-2** are connected directly to the signaling sewer **104** and form the first level **116-1** of the IP tree **114**. The printers **106** which are a part of the first level **116-1** may be referred to as primary nodes. Similarly the printers **106-3**, **106-4**, **106-5** and **106-6** which are connected to one of the primary nodes of the IP tree **114** form the second level **116-2** of the IP tree **114**. The printers **106** which are a part of the first level **116-1** may be referred to as secondary nodes.

In one example, the IP tree **114** may comprise of any number, represented by N, of levels. The Nth level **116**-N may include any number of printers, represented by M. The printers **106** which are at a same level of the IP tree **114** are referred to as peer nodes. Each printer **106** at the N^{th} level is connected to one printer **106** which is at $(N-1)^{th}$ level. The connected printer **106** at the $(N-1)^{th}$ level is referred as the parent node of the printer **106** at the N^{th} level. Similarly, each printer **106** at the N^{th} level may be connected to one or more printers **106** which is at $(N+1)^{th}$ level. The connected printers **106** at the $(N+1)^{th}$ level is referred as the child nodes of the printer **106** at the N^{th} level.

In one example, the signaling server **104** may restrict the depth of the IP tree **114** to a predefined number of levels **116**. Further, the signaling system **104** may restrict the number of peer nodes to a predefined number at each level **116** of the IP tree **114**.

In operation, on the print server **102** receiving a print job to be executed by a particular printer, such s the printer **106-6**, the print server **102** transmits a direct connection request with the printer **106-6** to the signaling server **104**. The signaling server **104** may implement various processes of modifying IP address information, such as network address translation (NAT), in IP packet headers of the direct connection request to route the direct connection request to the printer **106-6**. The printer **106-6** then sends a connection request, denoted by **118-1**, to the print server **102**, for direct connection. On the direct connection, indicated by communication channel **118-2**, being established the print server **102** transmits the print job to the printer **106-6** for execution. On completion of the print job, the print server **102** terminates the communication channel **118-2**.

Thus, the network printing system **101**, described herein, facilitate network printing using a reduced number of print servers **102**. Further, in case of a glitch on one of the nodes, only the child nodes of the affected node, shall attempt to reconnect with the affected node or with the peer nodes of the affected node. This significantly educes the number of reconnection requests.

FIG. **2***a* schematically illustrates the components of a printer **106**, according to an example of the present subject matter. In one example, the printer **106** includes a processor (not shown in figure) and a registration request module **226** communicatively coupled to the processor. In said example, the registration request module **226** transmits a connection request to a parent node. The parent node may be the signaling server **104** or another printer **106**. In response to the connection request, the registration request module **226** may receive a connection acknowledgement message or a list of child nodes, of the parent node.

On receiving, the connection acknowledgement message, the; registration request module **226** establishes a connection with the parent node. If the connection acknowledgement message is not received, the registration request module **226** transmits the connection request to at least one of the child nodes, of the parent node. The working of the printer **106** is explained in greater detail in conjunction with FIG. **2***b*.

FIG. **2***b* schematically illustrates the components of the signaling server **104** and the printer **106**, according to another example of the present subject matter.

In one implementation, the signaling server **104** includes a processor **202**, and a memory **204** connected to the processor **202**. The processor **202** may include microprocessors, microcontrollers, and logic circuitries. Among other capabilities, the processor **202** may fetch and execute computer-readable instructions stored in the memory **204**.

The memory **204**, communicatively coupled to the processor **202**, can include any non-transitory computer-readable medium known in the art including, volatile memory and nonvolatile memory, such as read only memory (ROM), flash memories, hard disks, optical disks, and magnetic tapes.

Further the signaling server **104** includes interfaces **206**. The interfaces **206** may include a variety of commercially available interfaces, for example, interfaces for peripheral device(s), such as data input output devices, referred to as I/O devices, storage devices, network device. The interfaces **206** facilitate the communication of the signaling server **104** with various communication and computing devices and various communication networks such as networks that use a variety of protocols, for example, Hypertext Transfer Protocol (HTTP), Extensible Messaging and Presence Protocol (XMPP) and Transmission Control Protocol/Internet Protocol (TCP/IP).

Further, the signaling server **104** may include modules **208**. The modules **208** may be coupled to the processor **202**.

The modules **208**, amongst other things, include routines, programs, objects, components, data structures, etc., which perform particular tasks or implement particular abstract data types. The modules **208** may also be implemented as, signal processor(s), state machine(s), logic circuitries, and/or any other device or component that manipulate signals based on operational instructions.

Further, the modules **208** can be implemented in hardware, computer-readable instructions executed by a processing unit, or by a combination thereof. In said implementation, the modules **208** include a printer registration module **210**, a routing module **212** and other module(s) **214**. The other module(s) **214** may include programs or coded instructions that supplement applications or functions performed by the signaling server **104**.

In an example, the signaling server **104** includes data **216**. In said implementation, the data **216** may include IP index data **218**. Nodes data **220** and other data **222**. The other data **222** may include data generated and saved by the modules **208** for providing various functionalities of the signaling server **104**.

In one implementation, the signaling server **104** is communicatively coupled to the printers **106** over a communication network **224**. The communication network **224** may include any commercially available telecommunication network and improvements thereon, or any of the public communication networks that use any of the commonly used protocols, for example, Hypertext Transfer Protocol (HTTP) and Transmission Control Protocol/Internet Protocol (TCP/IP). In one example, the printer **106** includes the registration request module **226** and a connection maintenance module **228**.

In operation, the registration request module **226** of the first printer **106** may send a connection request to the signaling server **104** over the communication network **224**. The printer registration module **210** receives the request and determines whether the signaling sewer **104** is already connected with the pre-defined threshold number of printers **106**. In case, the printer registration modulo **210** transmits a connection acknowledgement message to the printer **106** and establishes a connection with the printer **106**. Further, the routing module stores the IP address of the printer **106** as IP index data **218**. Thereafter, the printer registration module **210** accepts connection requests till the signaling server **104** is connected to the pre-defined threshold number of printers **106**.

If a N^{th} printer **106** transmits a connection request after the signaling server **104** is connected to the pre-defined threshold number of printers **106**, the printer registration module **210** transmits a list of the IP addresses of its child nodes. Thereafter, the registration request module **226** of the N^{th} printer **106** sends a connection request to the child nodes of the signaling server **104** in an ascending order of the geographical distance of the child node from the N^{th} printer **106**. For the sake of explanation, it is assumed that the first printer **106** is geographically closest to the N^{th} printer **106**.

On receiving the connection request from the N^{th} printer **106**, the connection maintenance module **228** verifies whether the number of first printer **106** has reached the pre-defined threshold number. In case, the pre-defined threshold number has not been reached, the connection maintenance module **228** of the first printer **106** transmits a connection acknowledgement message to the N^{th} printer **106** and establishes a connection with the N^{th} printer **106**. The connection maintenance module **228** of the first printer **106** also transmits a list of its peer nodes to the N^{th} printer **106**.

In one example, connection maintenance module **228** of each printer may transmit the IP addresses of its parent node and child nodes to the routing module **212** of the signaling server **104**. The routing module **212** may store the same as IP index data **218** to route data to any particular printer **106**.

On receiving a print job to be executed by a particular printer, the print server **102** transmits a direct connection request with the printer **106** to the routing module **212** of the signaling server **104**. The routing module **212** may implement various processes of modifying IP address information in IP packet headers of the direct connection request to route the direct connection request to the printer **106**. The registration request module **226** of printer **106** then sends a connection request to the print server **102** for direct connection. On the direct connection being established, the print server **102** transmits the print job to the printer **106** for execution. On completion of the print job, the connection maintenance module **228** terminates the communication channel **108-2**

Thus, the signaling server **104** facilitate network printing using a reduced number of print servers **102** as only the printers **106** which have to execute a print job shall be connected to the print server **102**. Further, in case of a glitch on one of the nodes, only the child nodes of the affected node, shell attempt to reconnect with the affected node or with the peer nodes of the affected node. This significantly reduces the number of reconnection requests.

FIG. **3** illustrates a method **300** for network printing, according to an example of the present subject matter. FIG. **4** illustrates a method **400** for network printing, according to another example of the present subject matter. FIG. **5** illustrates a method **500** for network printing, according to another example of the present subject matter. The order in which the methods **300**, **400** and **500** are described is not intended to be construed as a limitation, and any number of the described method blocks can be combined in any order to implement the methods **300**, **400** and **500**, or an alternative method. Additionally, individual blocks may be deleted from the methods **300**, **400** and **500** without departing from the spirit and scope of the subject matter described herein. Furthermore, the methods **300**, **400** and **500** may be implemented in any suitable hardware, computer-readable instructions, or combination thereof.

The steps of the methods **300**, **400** and **500** can be performed by programmed computers. Herein, some examples are also intended to cover program storage devices, for example, digital data storage media, which are machine or computer readable end encode machine-executable or computer-executable programs of instructions, where said instructions perform some or all of the steps of the described methods **300**, **400** and **500**. The program storage devices may be, for example, digital memories, magnetic storage media, such as a magnetic disks and magnetic tapes, hard drives, or optically readable digital data storage media.

With reference to method **300** as depicted in FIG. **3**, as depicted in block **302**, a connection request is received from the printer **106**. In one implementation, the printer registration module **210** of the signaling server **104** receives the connection request from the printer **106**. In another example, the connection maintenance module **228** of the printer **106** receives the connection request from another printer **106**.

At block **304**, it is determined whether the number of directly connected printers has reached a predefined threshold number. In one implementation, the printer registration module **210** of the signaling server **104** determines the number of child nodes, i.e., printers **106**, connected to the

signaling server **104**. In another example, the connection maintenance module **228** of the printer **108** determines the number of child nodes of the printer **106**.

If at block **304** it is determined that the number of directly connected printers has reached a predefined threshold number, then as illustrated at **306**, a list of child nodes in a same or nearby geographical location, is transmitted to the printer **106**. In one implementation, the printer registration module **210** of the signaling server **104** transmits the list of child nodes to the printer **106**.

If at block **304**, it is determined that the number of directly connected printers has not reached a predefined threshold number, then, as illustrated at **308**, a connection acknowledgement message is transmitted to the printer **106**. In one example, the printer registration module **210** of the signaling server **104** transmits the connection acknowledgement message to the printer **106** and establishes a communication channel between the printer **106** and the signaling server **104**.

With reference to method **400** as depicted in FIG. **4**, as depicted in block **402**, a request to connect to the signaling server **104** is transmitted by the printer **106**. In one implementation, the registration request module **226** of the printer **106** may generate and transmit the request to the signaling server **104**.

As illustrated in block **404**, a response is received from the signaling server **104**. In one example, the connection maintenance module **228** received the response from the signaling server **104**.

At block **406**, it is determined whether the response is a connection acknowledgement message. In one implementation, the connection maintenance module **228** determines whether the response is a connection acknowledgement message.

If at block **406**, the response is determined to be a connection acknowledgement message, then, as depicted in block **408**, the printer **106** connects to the signaling server **104**. In one implementation, the connection maintenance module **228** establishes connection with the signaling server **104**.

If at block **406**, the response is determined not to be a connection acknowledgement message, then, as depicted in block **410**, the printer **106** receives a list of child nodes or peer nodes, in a same or nearby geographical location, from the signaling server **104**. In one implementation, the connection maintenance module **228** received the list of child nodes end peer nodes from the signaling server **104**.

As shown in block **412**, a request to connect to at least one of the nodes in the list is transmitted by the printer **106**. In one implementation, the registration request module **226** transmits the request to connect to at least one of the nodes in the list in a random order. In another implementation, the registration request module **226** transmits the request to connect to at least one of the nodes in the list in an ascending order of geographical distance between the printer **106** and the node.

At block **414**, it is determined whether a connection acknowledgement message is received from the at least one node. In one implementation, the connection maintenance module **228** determines whether a connection acknowledgement message has been received from the at least one node.

If at block **414**, the connection acknowledgement message is received then, as illustrated in block **416**, a connection is established with the at least one node. In one example, the connection maintenance module **228** establishes the connection with the at least one node.

If at block **414**, the connection acknowledgement message is not received then, as illustrated in block **412**, a request to connect to at least one of the nodes in the list is transmitted by the printer **106**.

With reference to method **500** as depicted in FIG. **5**, as depicted in block **502**, a request to execute a print job is received by the printer **106**. In one implementation, the print server **102** transmits the request to perform the print job to the signaling server **104**. The routing module **212** of the signaling server **104** routes the request to the printer **106**.

As illustrated in block **504**, a request to connect to a print server **102** is requested by the printer **106**. In one implementation, the connection maintenance module **228** of the printer **106** generates the request to connect to the print server **102**.

As shown in block **506**, a connection acknowledgement message is received from the print server **102**. In one example, the connection maintenance module **228** receives the connection acknowledgement message from the print server **102**.

At block **508**, a connection with the print server **102** is established. In one implementation, the connection maintenance module **228** establishes a communication channel with the print server **102**.

As depicted in block **510**, the print job is received. In one example, the connection maintenance module **228** receives the print job from the print server **102**.

As illustrated in block **512**, the print job is executed. As depicted in block **514**, the connection with the print server **102** terminated. In one implementation, the connection maintenance module **228** terminates the connection with the print server **102** on completion of the execution of the print job.

FIG. **6** illustrates a computer readable medium **600** storing instructions for network printing, according to an example of the present subject matter. In one example, the computer readable medium **600** is communicatively coupled to a processing unit **602** over communication link **604**.

For example, the processing unit **602** can be a computing device, such as a server, a laptop, a desktop, a mobile device, and the like. The computer readable medium **600** can be, for example, an internal memory device or an external memory device or any commercially available non transitory computer readable medium. In one implementation, the communication link **604** may be a direct communication link, such as any memory read/write interface. In another implementation, the communication link **604** may be an indirect communication link, such as a network interface. In such a case, the processing unit **602** can access the computer readable medium **600** through a network.

The processing unit **602** and the computer readable medium **600** may also be communicatively coupled to data sources **606** over the network. The data sources **606** can include, for example, databases and computing devices. The data sources **606** may be used by the requesters and the agents to communicate with the processing unit **602**.

In one implementation, the computer readable medium **600** includes a set of computer readable instructions, such as the registration request module **226**. The set of computer readable instructions can be accessed by the processing unit **602** through the communication link **604** and subsequently executed to perform acts for network printing.

On execution by the processing unit **602**, the registration request module **226** receives a request from a new node to connect to the printer. The registration request module **226** then determines whether a number of child nodes of the printer has reached a predefined threshold number. On

determining the number of child nodes not to have reached the predefined threshold number, the registration request module **226** transmits a connection acknowledgement message to the new node. If the number of child nodes is determined to have reached the predefined threshold number, the registration request module **226** transmits a list of child nodes of the printer, to the new node.

Although implementations for network printing have been described in language specific to structural features and/or methods, it is to be understood that the appended claims are not necessarily limited to the specific features or methods described. Rather, the specific features and methods are disclosed as examples of systems and methods for network printing.

I claim:

1. A method for network printing, the method comprising:

receiving in a signaling server, a request from a new node to connect to the signaling server, wherein the new node is a printer;

determining whether a number of child nodes of the signaling server has reached a predefined threshold number;

transmitting a connection acknowledgement message to the node when the number of child nodes is less than the predefined threshold number;

transmitting a list of child nodes of the signaling server to the new node on determining the number of child nodes has reached the predefined threshold number, wherein the signaling server and the child nodes form a portion of a tree of nodes, and wherein receiving the list of child nodes from the signaling server causes the new node to attempt to establish connections with nodes in the tree of nodes until a node accepts a connection from the new node;

recording, in a data structure representing the tree of nodes, information describing the new node and information describing the connection between the new node and the node that accepted the connection from the new node;

receiving a request from a print server to connect to the new node for execution of a print job; and

route, based on the data structure representing the tree of nodes, the request to the new node to control the new node to connect to the print server and execute the print job.

2. A printer for network printing, the printer comprising:

a processor;

a registration request module, coupled to the processor, to:

transmit a connection request to a parent node of a tree of nodes;

receive at least one of a connection acknowledgement message and a list of child nodes of the parent node, as a response to the connection request;

establish a connection with the parent node if the connection acknowledgement message is received;

transmit the connection request to at least one of the child nodes, of the parent node, if the connection acknowledgement message is not received; and

upon establishing a connection to a node in the tree of nodes, transmitting a signal to a signaling server in the tree of nodes to cause the signaling server to update data describing the tree of nodes with data describing the connection between the printer and the node in the tree of nodes; and

a connection maintenance module to:

receive a connection request, routed based on the data describing the tree of nodes to connect, to a print server to execute a print job;

establish a connection with the print server;

receive the print job;

execute the print job; and

terminate the connection with print server on completion of the execution.

3. The printer as claimed in claim **2**, wherein the registration request module further receives a list of peer nodes of the parent node.

4. The printer as claimed in claim **3**, wherein the connection maintenance module is further to:

sort the list of peer nodes in an ascending order of geographical distance from the printer;

transmitting a connection request to at least one of the peer nodes, based on the sorting, on detecting a connection break with the parent node.

5. The printer as claimed in claim **2**, wherein the connection maintenance module is further to:

receive a request from a new node to connect to the printer;

determine whether a number of child nodes of the printer has reached a predefined threshold number; and

transmit a connection acknowledgement message to the new node on determining the number of child nodes not to have reached the predefined threshold number.

6. The printer as claimed in claim **5**, wherein the connection maintenance module further transmits a list of peer nodes of the printer to the new node, wherein the new node connects to at least one of the peer nodes on detecting a break in connection with printer.

7. The printer as claimed in claim **5**, wherein the connection maintenance module further transmits a list of child nodes of the printer to the new node, on determining the number of child nodes to have reached the predefined threshold number.

8. A non-transitory computer-readable medium having a set of computer readable instructions that, when executed, cause a printer to:

receive a request from a new node to connect to the printer;

determine whether a number of child nodes of the printer has ached a predefined threshold number;

transmit a connection acknowledgement message to the new node on determining the number of child nodes not to have reached the predefined threshold number;

transmit a list of child nodes, of the printer, the new node on determining the number of child nodes to have reached the predefined threshold number;

receiving a request from a print server to connect to the new node for execution of a print job; and

route the request to the new node to control the new node to connect to the print server and execute the print job.

9. The non-transitory computer-readable medium as claimed in claim **8**, wherein the instructions executed further cause the printing system to:

transmit a connection request to a parent node;

receive at least one of a connection acknowledgement message and a list of child nodes, of the parent node, as a response to the connection request;

establish a connection with the parent node on receiving the connection acknowledgement message;

transmit the connection request to at least one of the child nodes, of the parent node, on not receiving the connection acknowledgement message;

receive a connection request to connect to a print server to execute a print job;

establishes a connection with the print server;

receives the print job; and

executes the print job.

* * * * *